



Multi-angle  
Imaging  
Spectro-  
Radiometer

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## In-Flight calibration of the EOS/ Multiangle Imaging SpectroRadiometer

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Sensor, Systems, and  
Next Generation Satellites VI  
EurOpto, Barcelona, Spain  
26-September-00

**• Data analysis**

Wedad Abdou	Vicarious calibration
Robert Ando	Desert targets
Carol Bruegge	Team lead
Brian Chafin	ARPGen code development and OBC* processing
Nadine Chafin	Calibration engineer; algorithm development and validation
David Diner	Instrument performance
Barbara Gaitley	Field instruments
Bill Ledebotter	AirMISR

**• AirMISR engineering and operations**

Bill Cunningham, Colin Mahoney, Dan Peters, Ghobie Saghri

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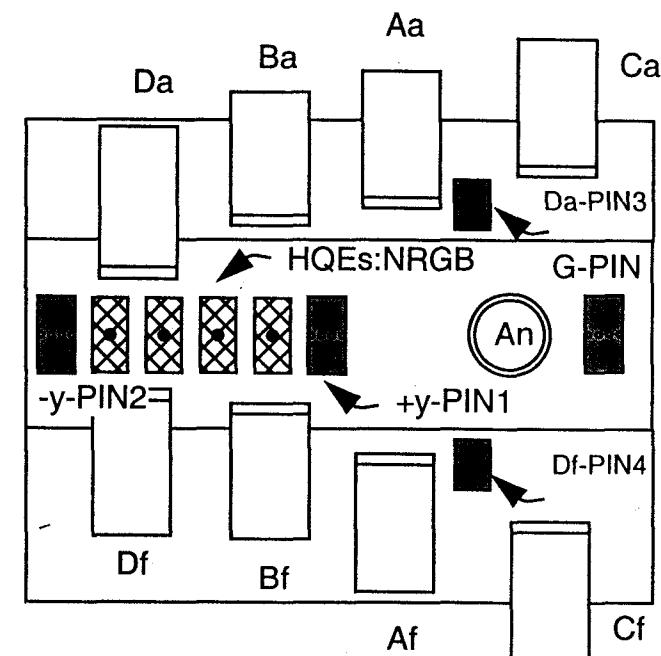
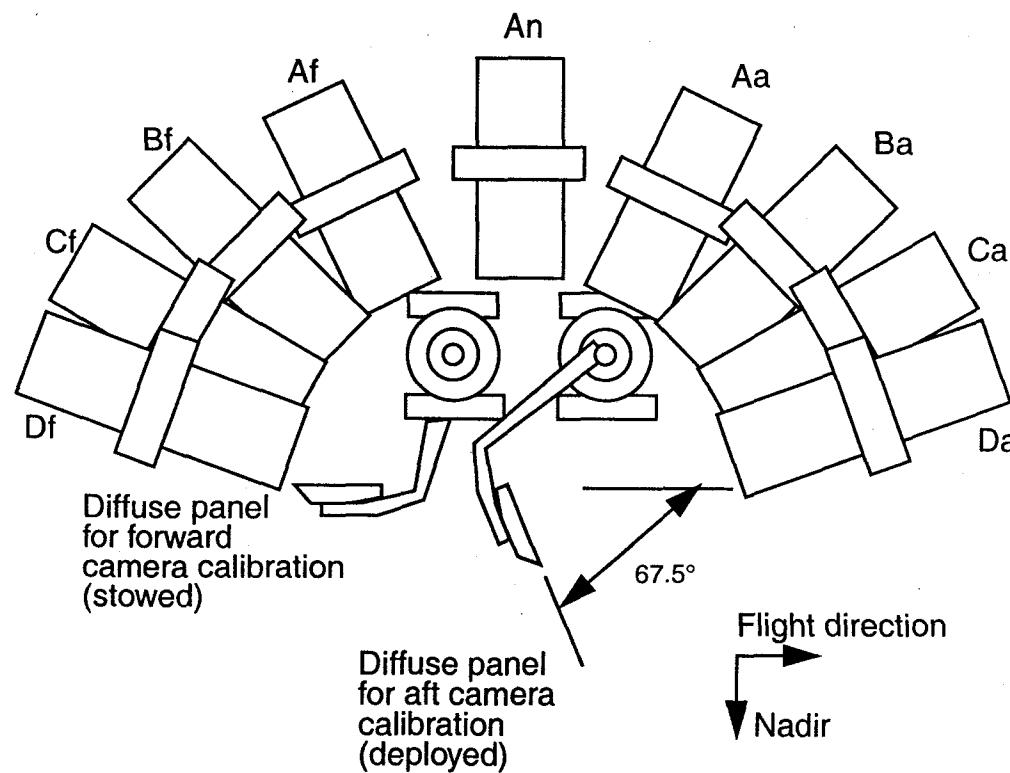
\* On-Board Calibrator (OBC)



# OUTLINE

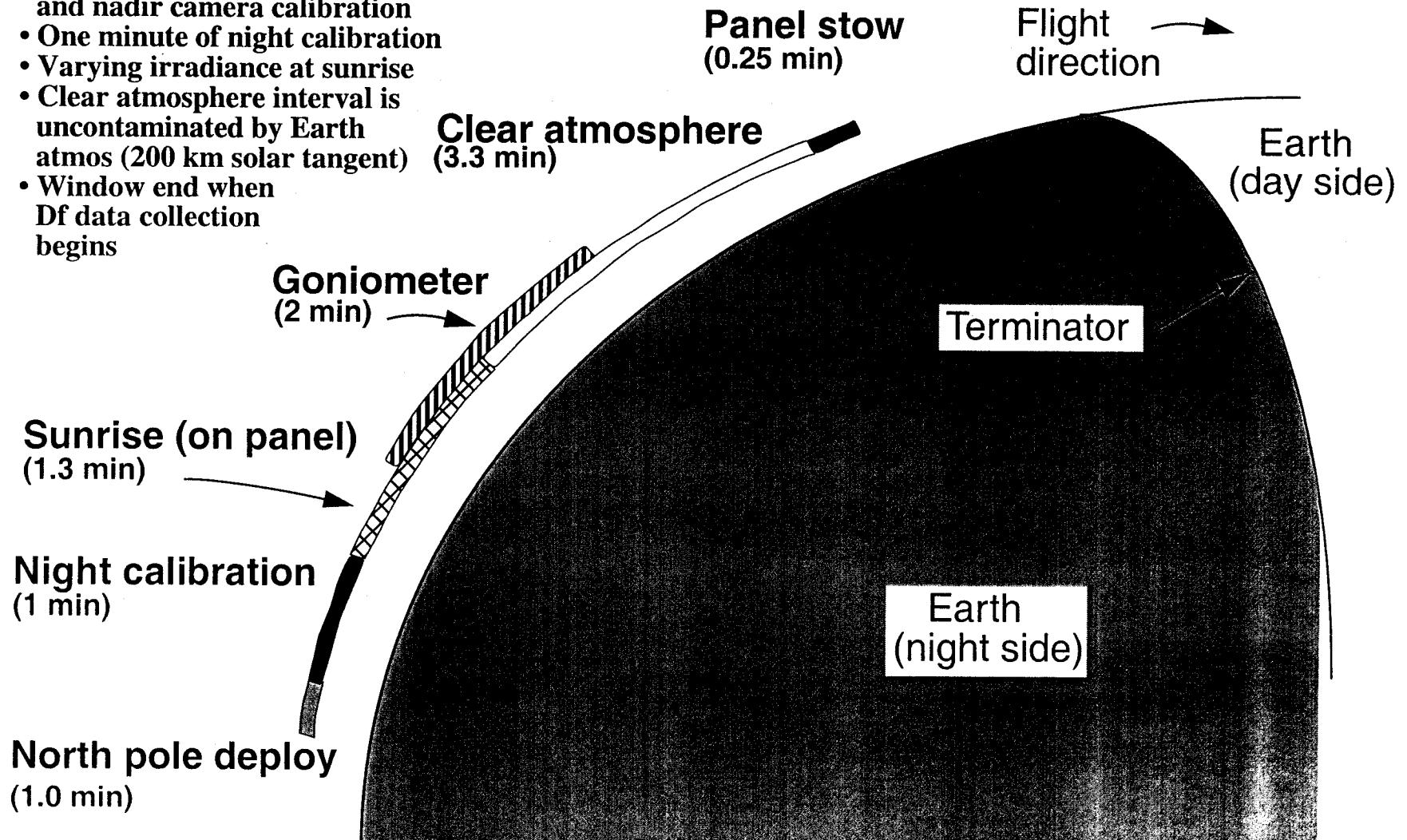


- OBC calibration concept
- First experimental results
- The new Ancillary Radiometric Product (ARP\_Ver3)
- Radiometric comparisons
- What next (ARP\_Ver4)



# IN-FLIGHT CALIBRATION: MISSION PLAN

- North Pole: panel deployed for aft and nadir camera calibration
- One minute of night calibration
- Varying irradiance at sunrise
- Clear atmosphere interval is uncontaminated by Earth atmos (200 km solar tangent)
- Window end when Df data collection begins





# EXPERIMENT TIMELINE



Experiment	Date	Time, UT	Orbit					
Cal_North	27-Feb-00, Sunday	23:34:24	1043		Cal_North	27-Apr-00, Thursday	14:01:01	1911
Cal_South	28-Feb-00, Monday	00:33:53	1043		Cal_South <sup>a</sup>	27-Apr-00, Thursday	16:39:15	1911
Cal_North	01-Mar-00, Wednesday	05:57:26	1076		Cal_North	11-Jun-00, Sunday	04:16:43	2575 ??
Cal_South	01-Mar-00, Wednesday	06:56:53	1076		Cal_South <sup>a</sup>	12-Jun-00, Monday	21:44:55	2585 ??
Cal_North	13-Mar-00, Monday	19:31:21	1259		Total: (6 Cal_Norths; 4 Cal_souths)			
Cal_North <sup>b</sup>	17-Mar-00, Friday	14:09:48	1314					

- a. Goniometer positioned to 58° in order to eliminate anomalous motor currents, attributed to panel/ goniometer blanket rubbing. Thus, Cal\_North and Cal\_South now separated in time
- b. Flight software modified. Removed averaging modes. Now 18 channels set to 1x1 including Cal\_North An\_blue and An\_green and Cal\_south An\_red and An\_nir. Began Cal\_North 40 seconds earlier. Next Cal\_South will move up by 10 seconds.

- The Ancillary Radiometric Product (ARP) is a collection of four data files, which consist of parameters used to characterize the optical performance of MISR.
- Three of the four files are used at the DAAC to construct MISR data products
- Only one file (In-flight calibration) is intended to change periodically throughout the six year mission duration

File name	Description	Used by DAAC	Updated in-flight
Preflight Characterization Data	<ul style="list-style-type: none"><li>• measured pixel spectral response functions for 7 zones within each of the 36 channels.</li></ul>		
Preflight Calibration Data	<ul style="list-style-type: none"><li>• spectral descriptors relevant to Level 1B1 and Level 2 standard products</li><li>• band weighted solar irradiances</li></ul>	√	
In-flight Calibration Data	<ul style="list-style-type: none"><li>• radiometric calibration coefficients, calibration uncertainties, signal-to-noise ratios, and Detector Data Quality Indicators.</li></ul>	√	√
Configuration Parameters	<ul style="list-style-type: none"><li>• threshold parameters and process control limits used by DAAC processes</li></ul>	√	



Algeria\_5  
Df\_green image  
shows fringes  
(ARP\_V1)

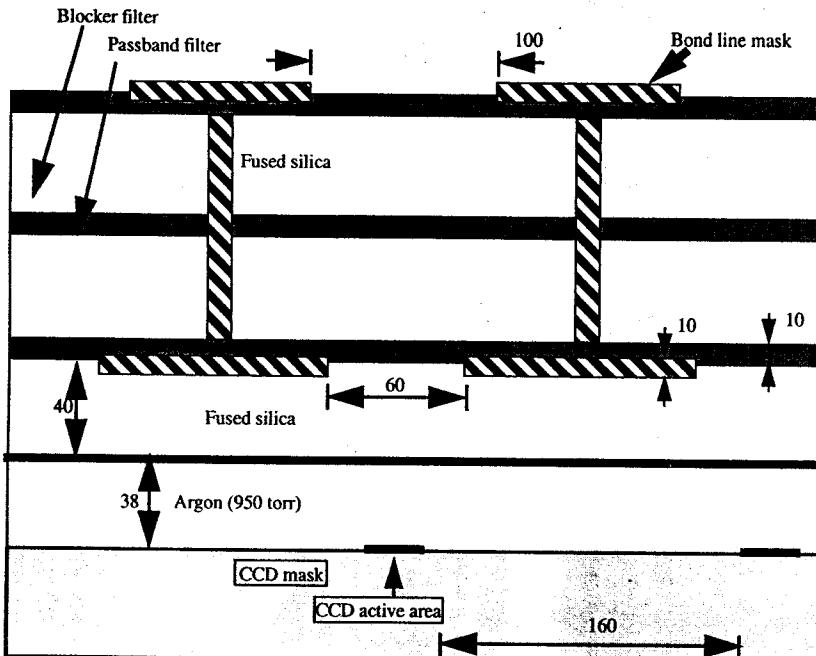


This is the same  
image, processed  
with ARP\_V3

## Interference basics

- the coherence length of light is inversely proportional to its bandwidth

## MISR focal plane



Robert Korechoff  
SPIE 2583, 25Aug95

units: micrometer

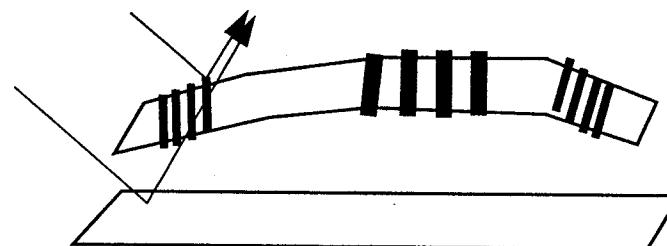
$$\Delta x = \frac{c}{\Delta v} = \frac{\lambda^2}{\Delta \lambda}$$

MISR parameter	Band			
	446	558	672	866
$\lambda$ , nm	446	558	672	866
$\Delta\lambda$ , nm				25 (minimum equivalent squareband assumed)
$\Delta x$ , $\mu\text{m}$	8	12	18	30

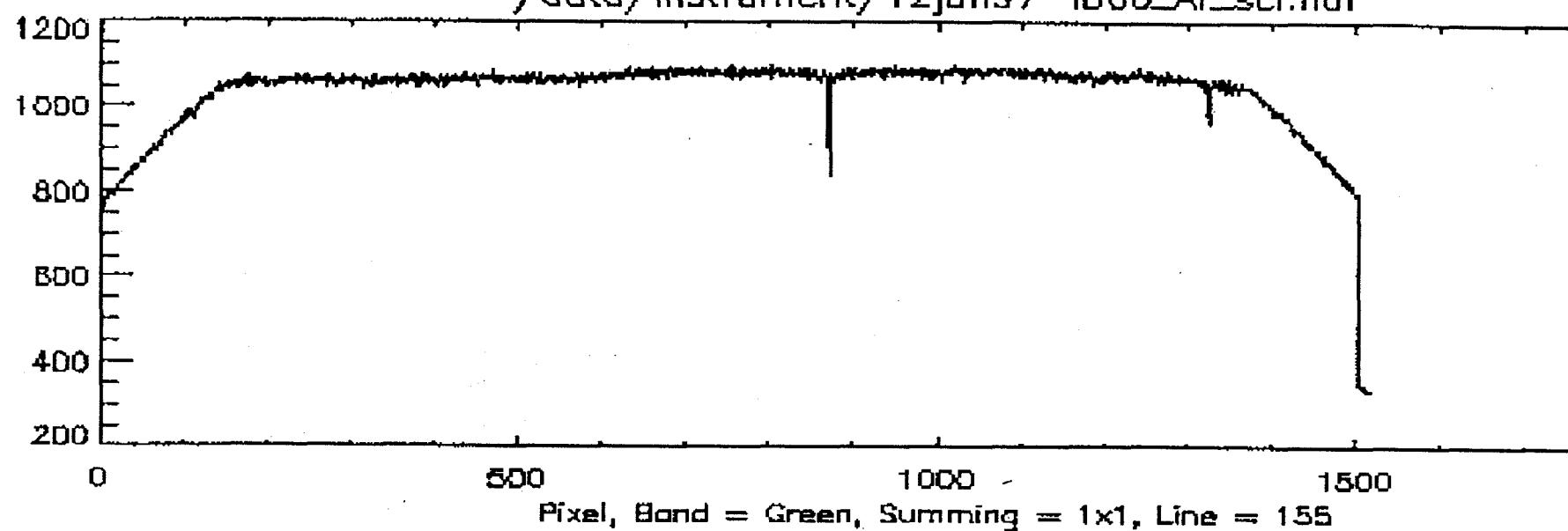
- two waves interfere according to their optical path differences

$$E^2 = E_1^2 + E_2^2 + 2E_1E_2 \cos(\delta)$$

$$\text{max at } \delta = \frac{2\pi}{\lambda} n \Delta d = 0, \pm n 2\pi$$



/data/instrument/12jun97-ib06\_Af\_sci.hdf





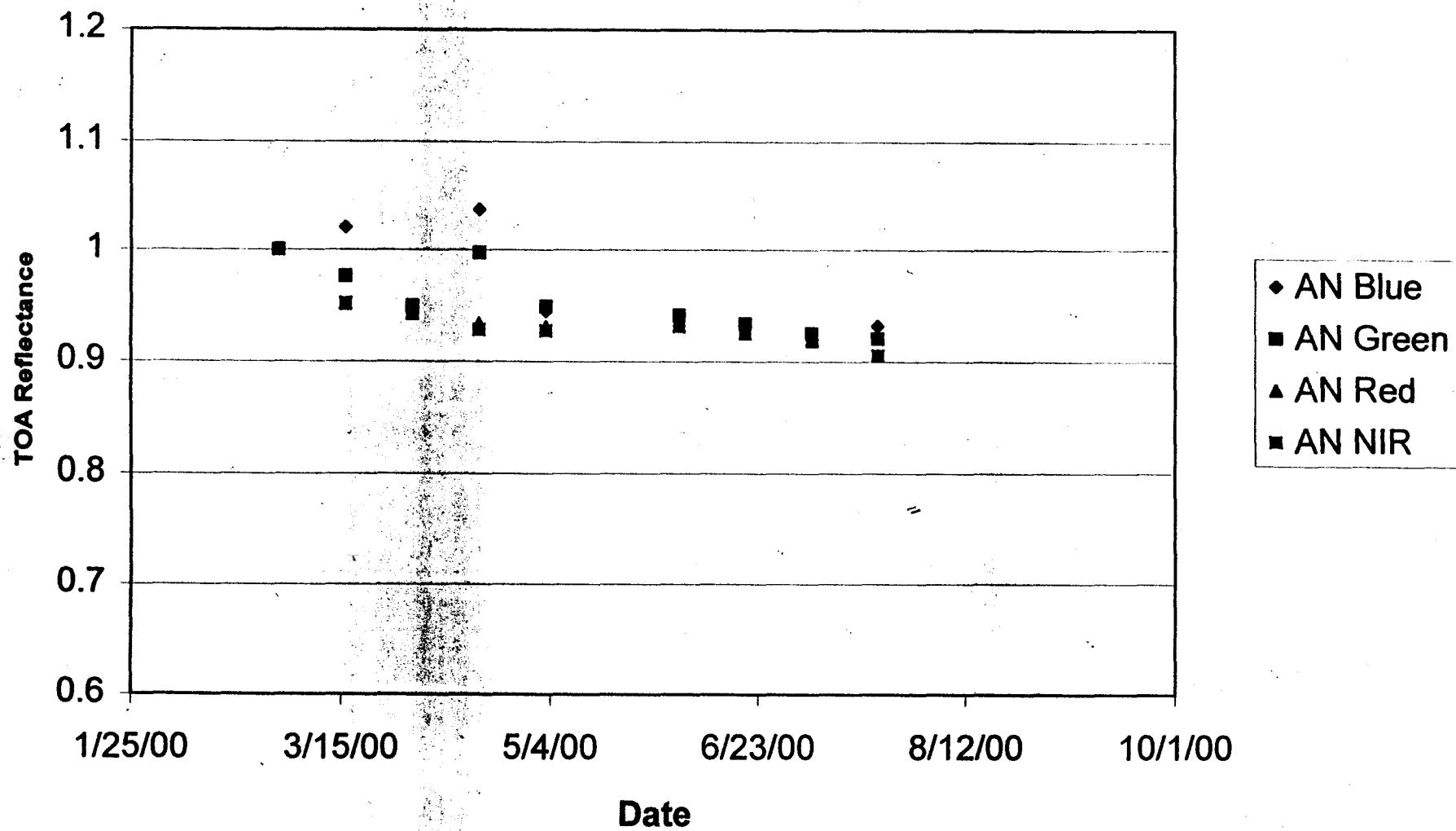
Algeria\_3 image  
shows vignetting  
of Aa camera



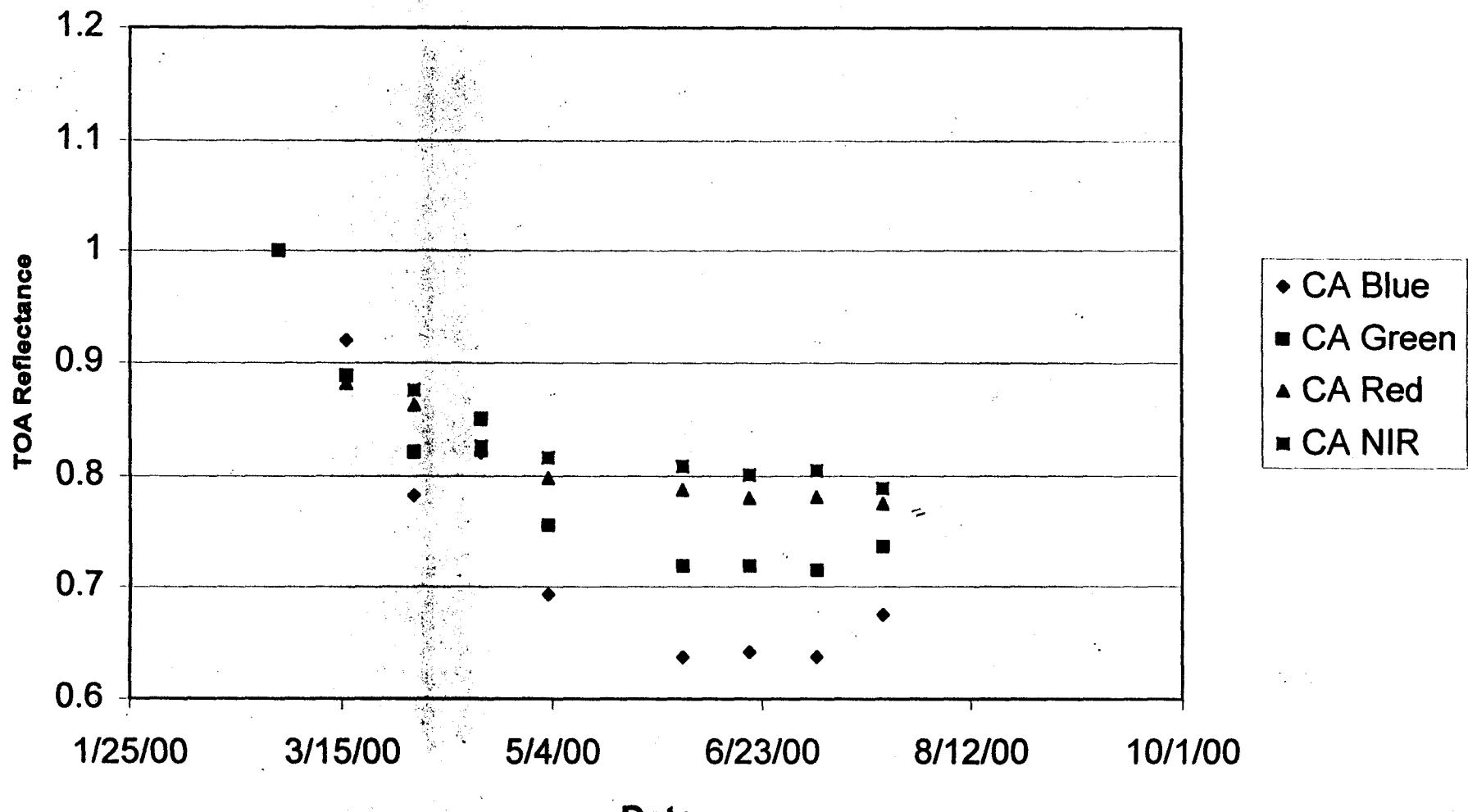
An camera image  
shows sharper  
image at swath  
edges

16Mar00 Path\_192 Orbit\_1297 Block\_66 L1B2 Imagine

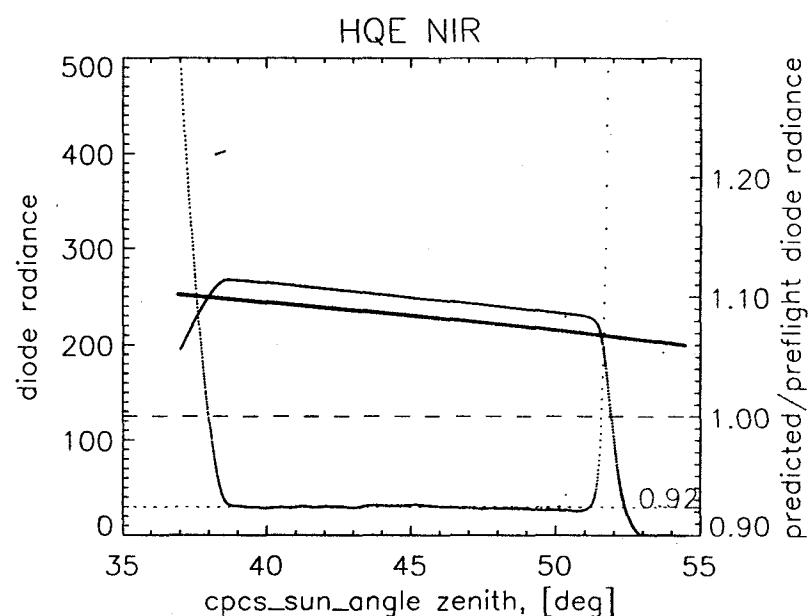
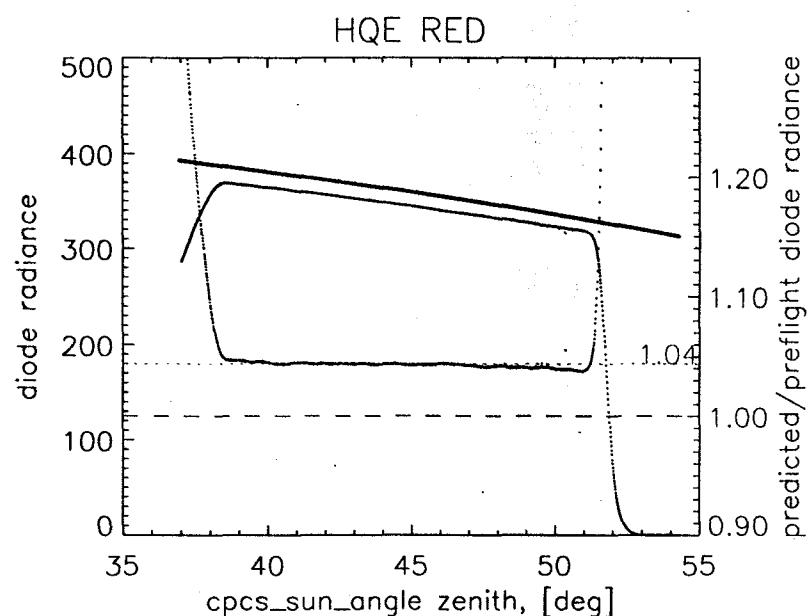
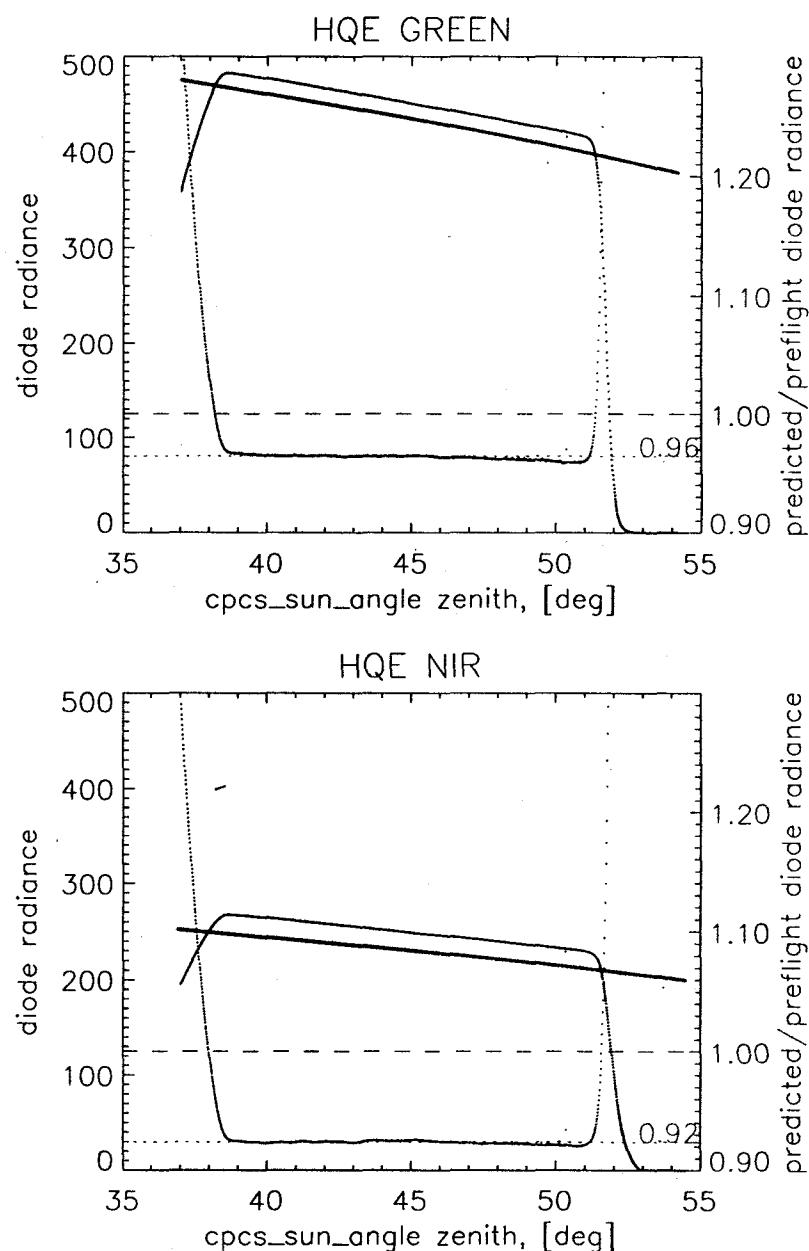
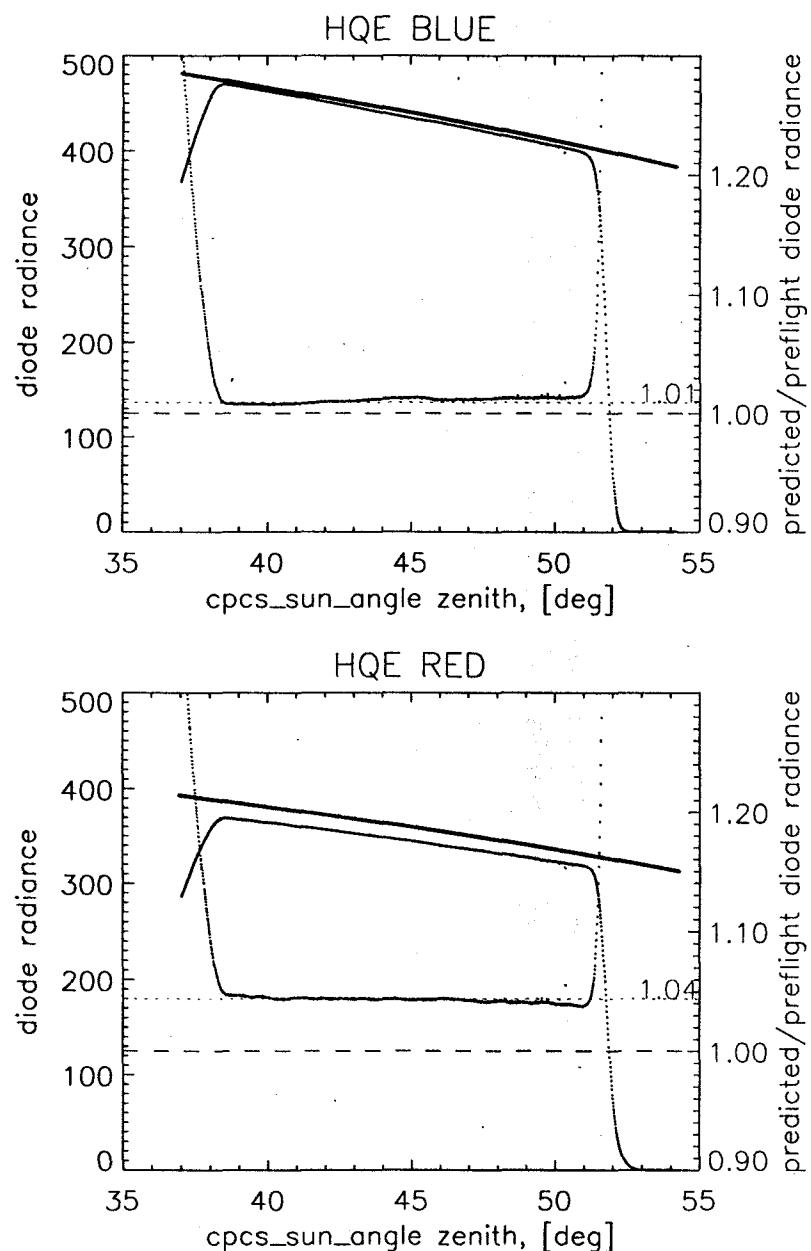
## Algeria\_3



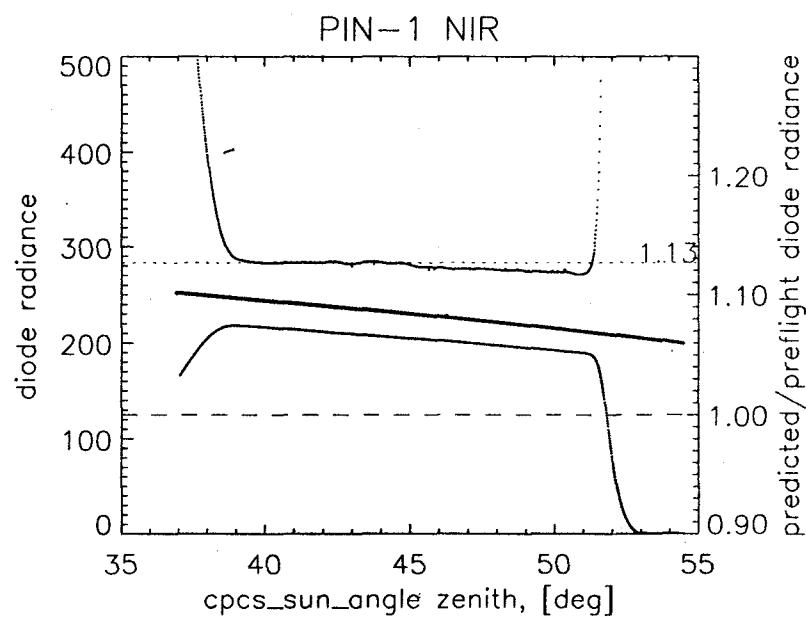
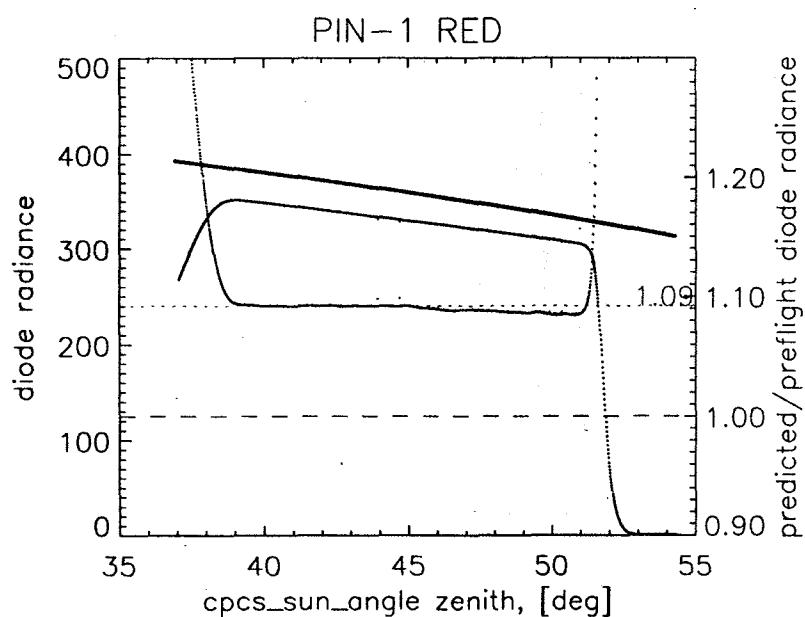
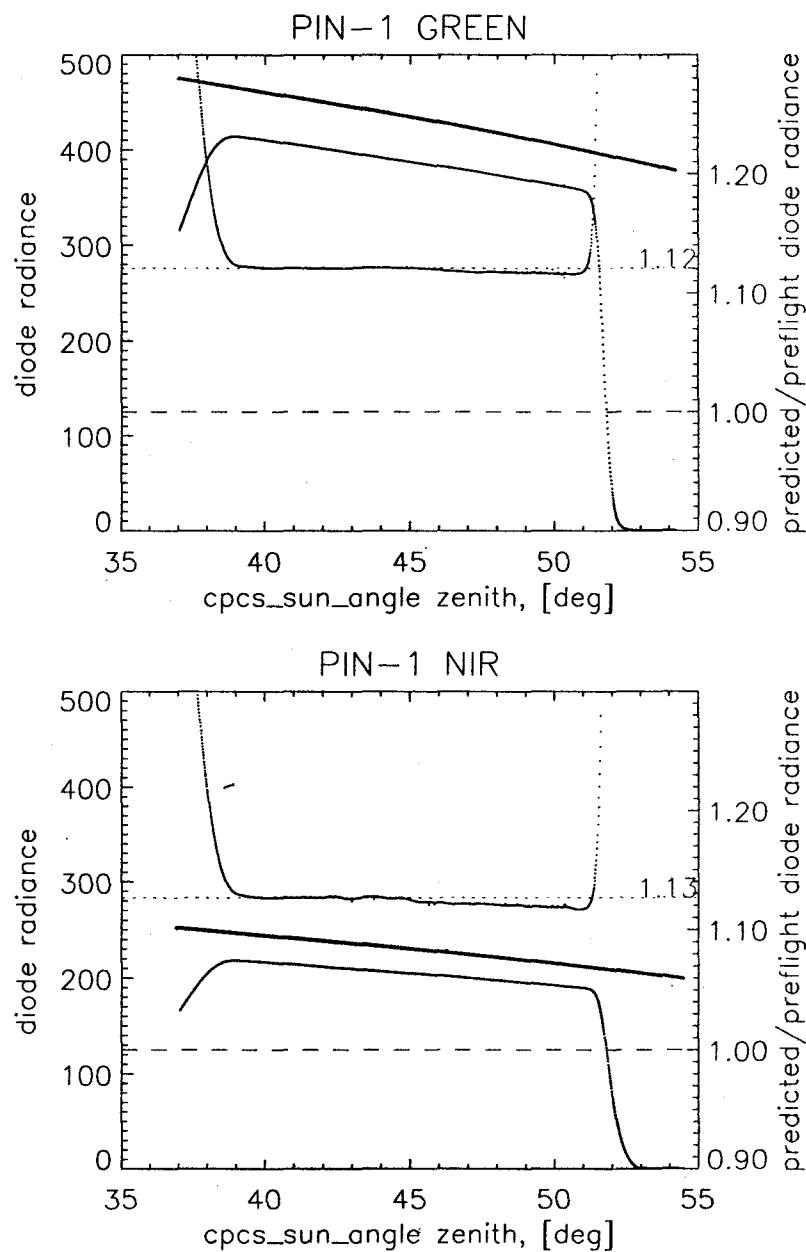
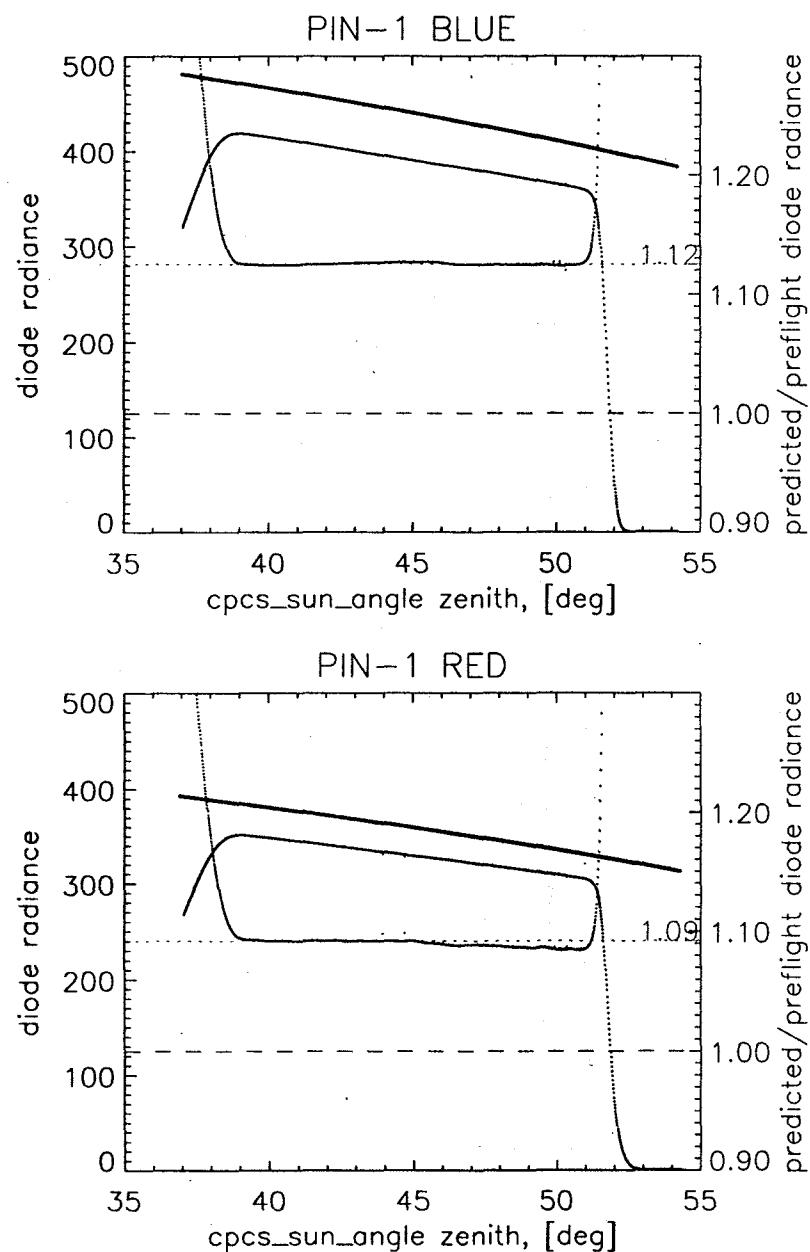
### Algeria\_3



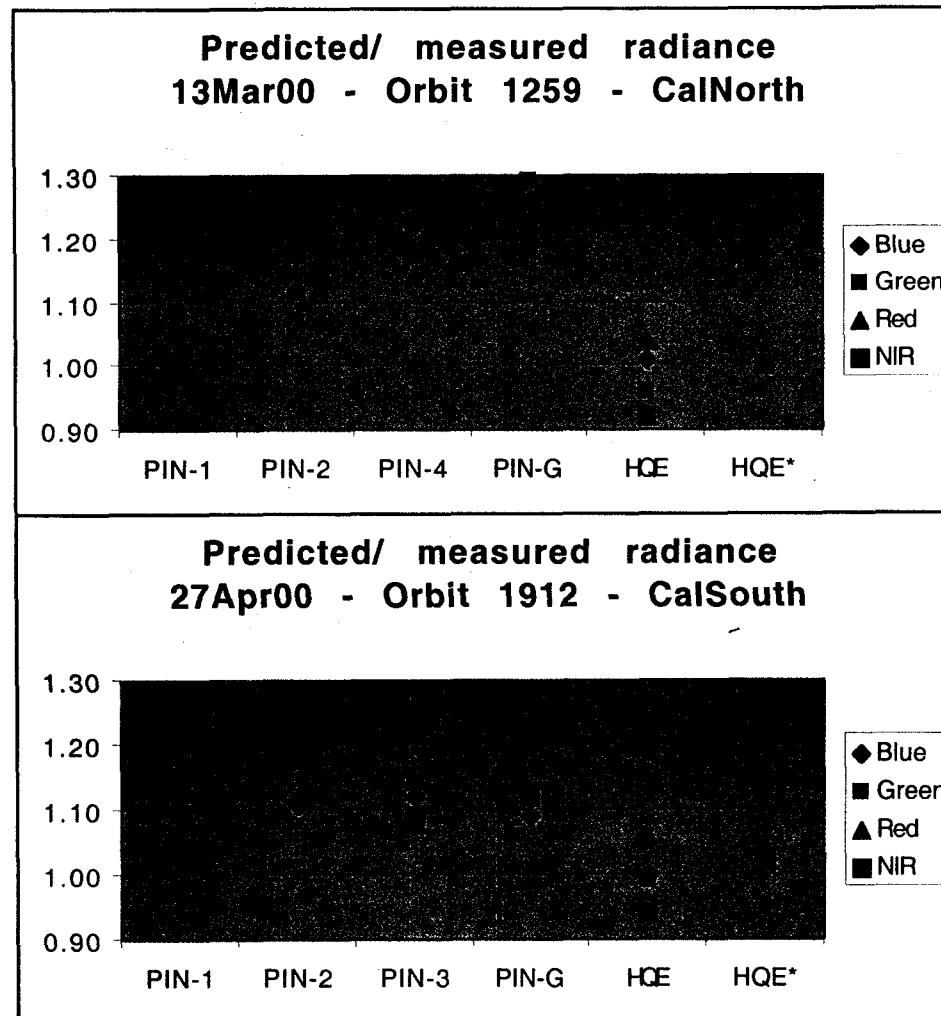
$$E_0 \mu_0 BRF/\pi$$

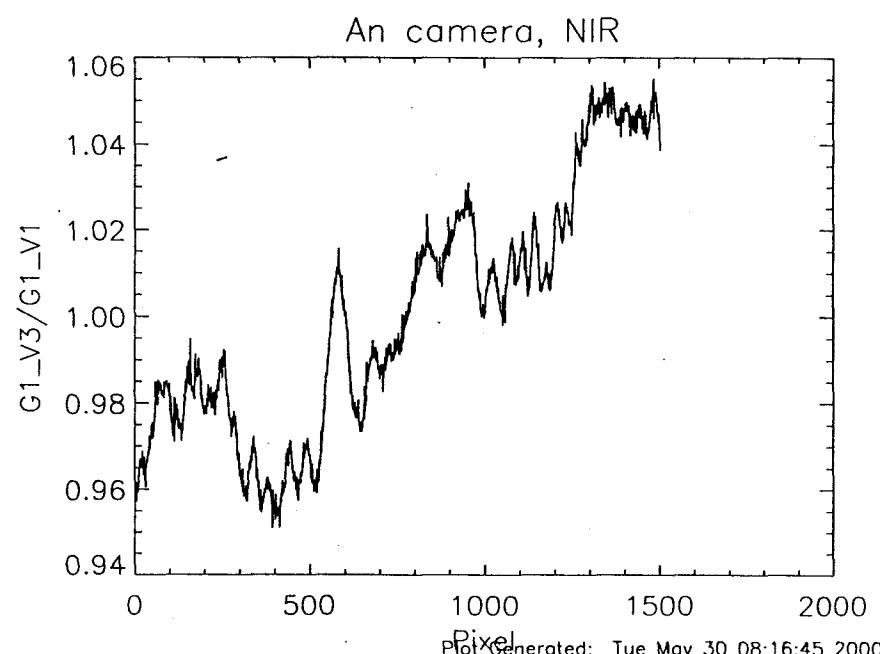
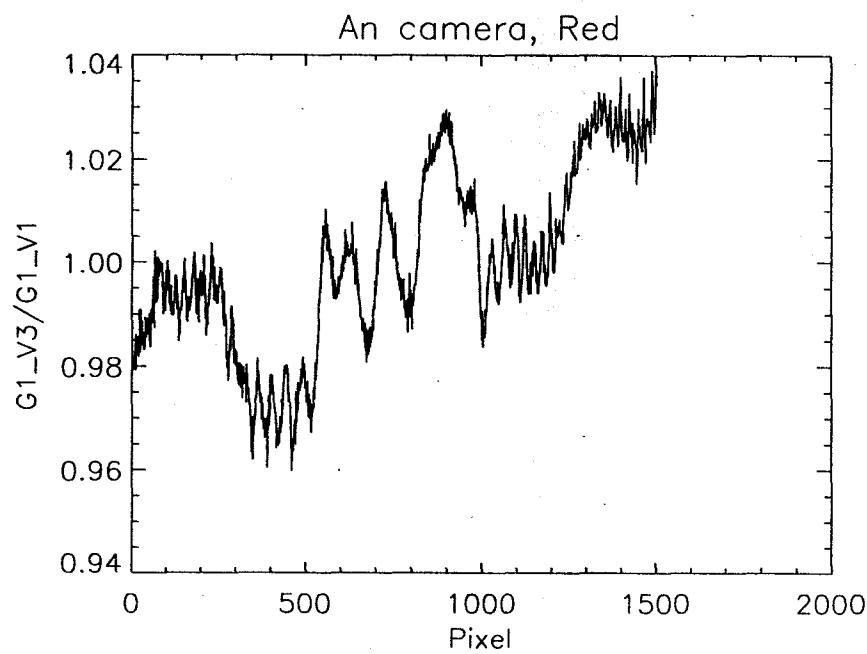
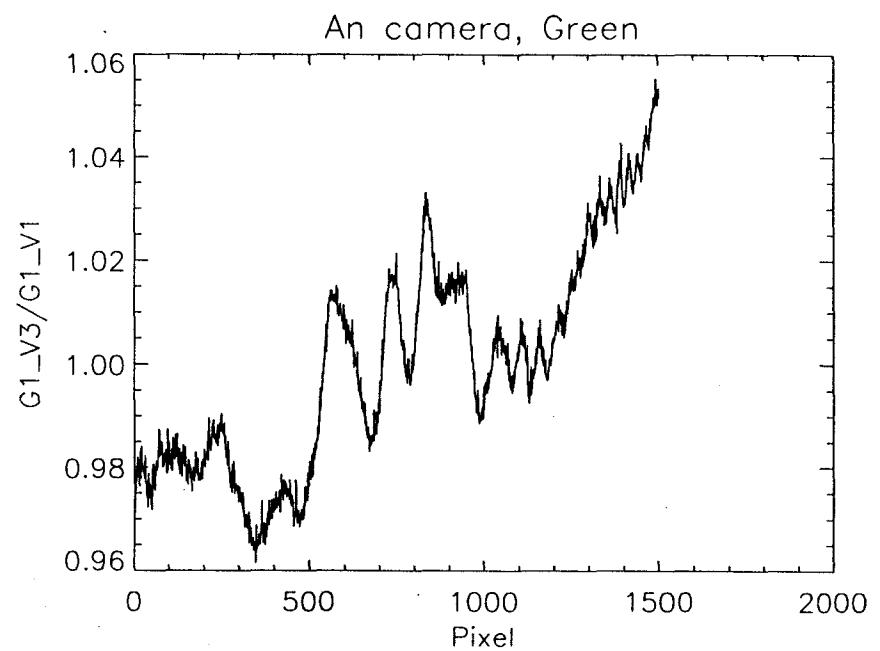
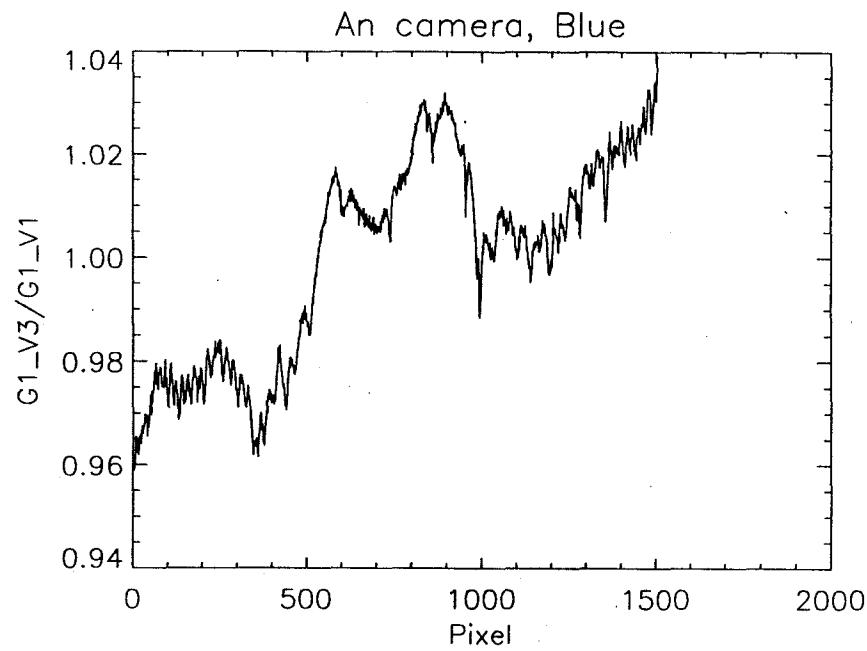


$$E_0 \mu_0 \text{BRF}/\pi$$

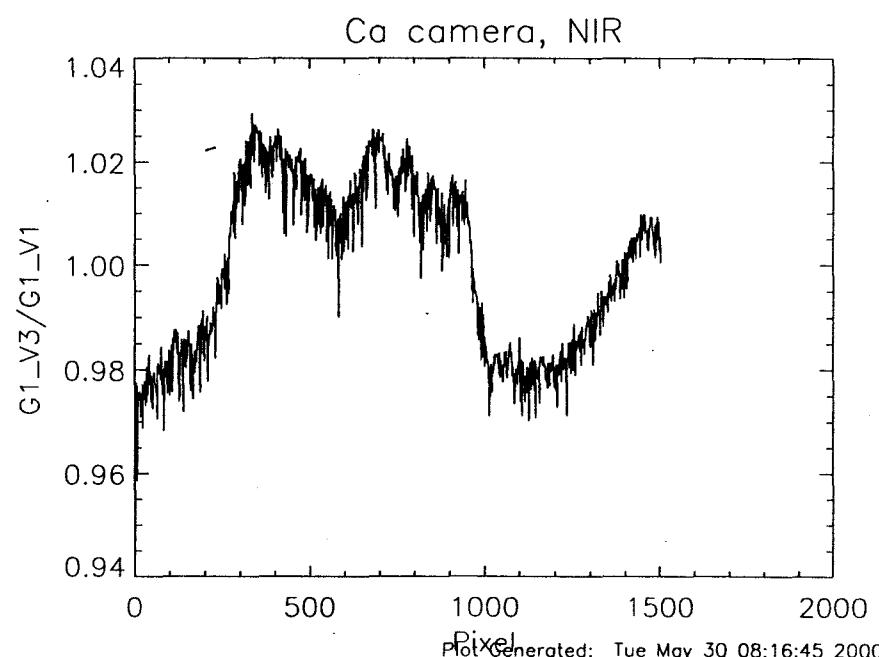
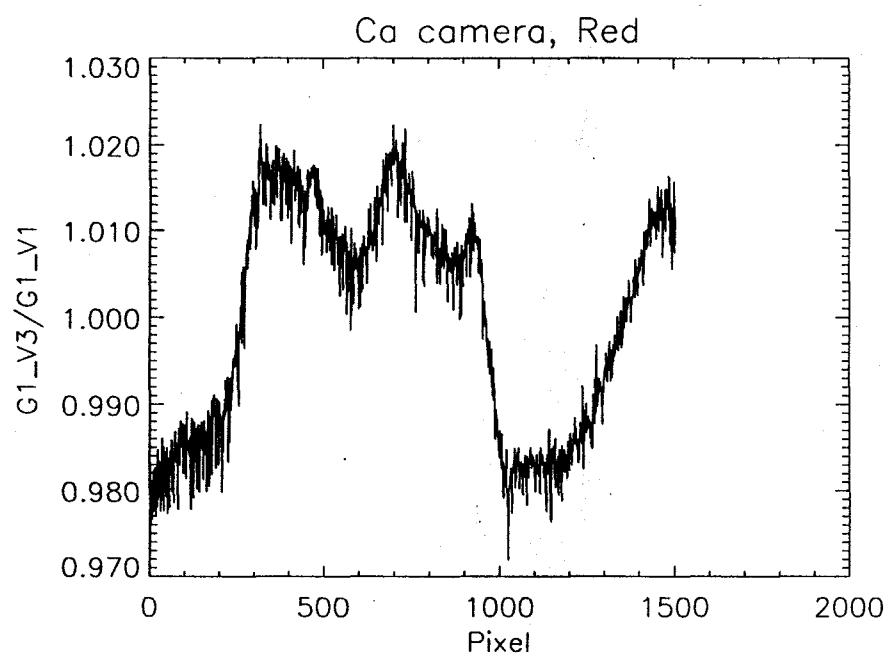
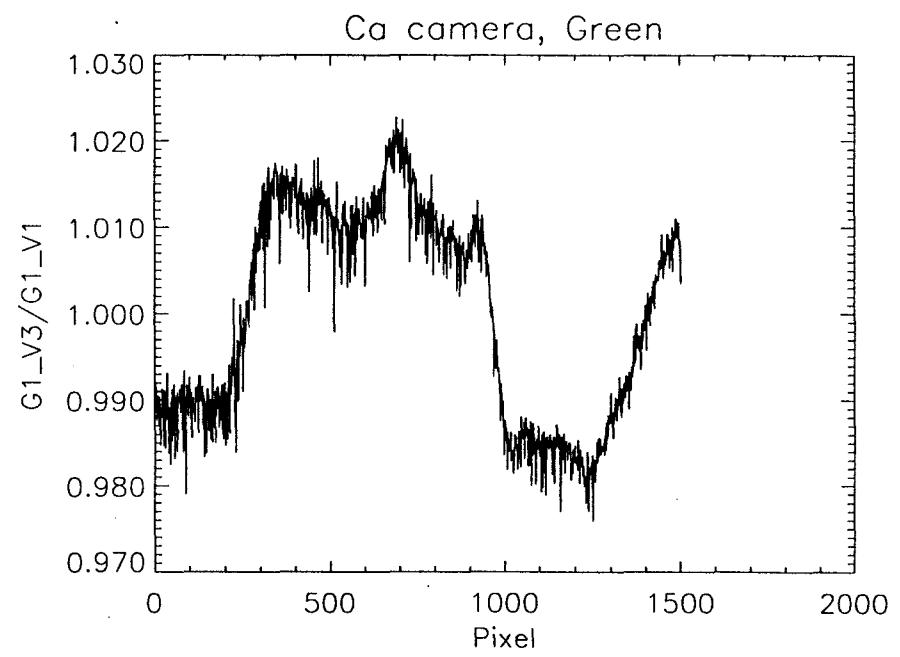
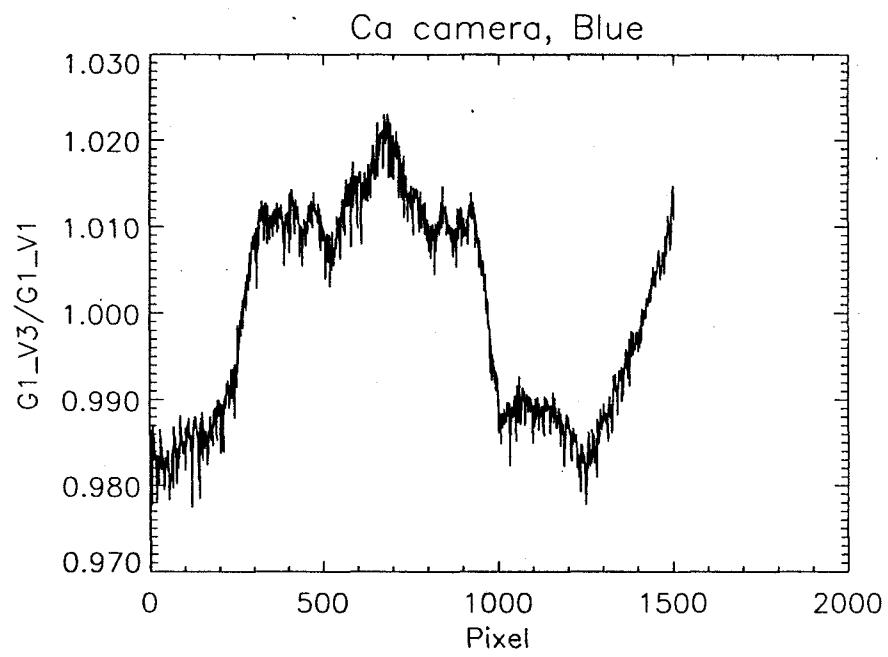


# DIFFUSE PANEL RADIANCE COMPARISON





Plot Generated: Tue May 30 08:16:45 2000  
Analyst: bchofin



Generated: Tue May 30 08:16:45 2000  
Analyst: bchotin



# ARP VERSION DIFFERENCES



Approach	INFLGT_Ver1	INFLGT_Ver3 <sup>a</sup>	INFLGT_Ver4
Date released	Preflight	June 2000	July 2000
Radiometric standard	Laboratory HQE (trapped photodiodes)	Preflight channel average	HQE green
Calibration equation	Quadratic, unconstrained intercept	Linear, constrained intercept	Linear, constrained intercept
Vignetting correction	None, problematic for Aa, Af	Corrected	Corrected
Fringing	Apparent	Reduced	Reduced
Uncertainties	Too high; seem to allow good aerosol retrievals	Kept same as Ver1	Will correct error
High accuracy camera-to-camera and band-to-band ratios	No	No	Yes. Will adjust HQE calibration constants such that measured and predicted ratios agree

a. INFLGT\_Ver2 has the same contents as INFLGT\_Ver1, but with a file format change.

**Summary**

- Evidence indicates that MISR cameras are well calibrated and stable, in absolute sense
- Improvement in camera-to-camera and band-to-band ratios of radiances should be provided by the next ARP release, Version 4.
- Uncertainties need to be estimated by cross comparison between independent methodologies, not from methodology error table

**Continuing studies**

- On-going work will continue to monitor camera stability with time, considering:
  - stability of cameras while viewing desert scenes (Saharan, Salar Chili, and western United States)
  - orbital averages of photodiodes and cameras

**Issues**

- How often do we calibrate (every 2 months ??)
  - Is there a risk to moving the calibration panels ?